CLAIMS:

1. A back-drivable robot head including:

   (a) a manually-graspable driving member;

   (b) a force sensor for sensing forces applied to the driving member by a user;

   (c) an arm for carrying a tool the position of which is to be controlled; and

   (d) a first rotation control mechanism for rotating the arm about a first axis in response to the sensed forces;

characterised in that the first rotation control mechanism comprises a first rotational motor (30') coupled to a first lead screw (32); and a bearing which moves longitudinally of the first lead screw as it rotates, the bearing being pivotally coupled to an offset crank (34) of or secured to the arm.

2. A robot head as claimed in claim 1 in which the first motor and the first lead screw are mounted for pivotal motion with respect to a frame of the head.

3. A robot head as claimed in claim 1 or claim 2 in which the first motor is directly secured to the first lead screw, without any intervening gears.

4 A robot head as claimed in any one of the preceding claims in which the first lead screw has a high lead angle.

5. A robot head as claimed in any one of the preceding claims including a first output position encoder for measuring the angular position of the arm about the first axis.

6. A robot head as claimed in any one of the preceding claims including a first input position encoder for measuring rotation of the first motor.

7. A robot head as claimed in claim 5 and claim 6 in which the measurement from the first output position encoder is compared with an expected arm position based on the measurement from the first input position encoder, and an alarm is raised if the expected position is inconsistent with the actual position.

8. A robot head as claimed in any one of the preceding claims including a second rotation control mechanism for rotating the arm about a second axis, the said mechanism comprising a second rotational motor (30') coupled to a second lead screw (32); and a bearing which moves longitudinally of the second lead screw as it rotates, the bearing being pivotably coupled to an offset crank (34) of or secured to the arm.

9. A robot head as claimed in claim 8 in which the second motor and the second lead screw are mounted for pivotal motion with respect to a frame of the head.

10. A robot head as claimed in claim 8 or claim 9 in which the second motor is directly secured to the second lead screw, without any intervening gears.

11. A robot head as claimed in any one of claims 8 to 10 in which the second lead screw has a high lead angle.

12. A robot head as claimed in any one of claims 8 to 11 including a second output position encoder for measuring the angular position of the arm about the second axis.

13. A robot head as claimed in any one of claims 8 to 12 including a second input position encoder for measuring rotation of the second motor.

14. A robot head as claimed in claim 12 and claim 13 in which the measurement from the second output position encoder is compared with an expected arm position based on the measurement from the second input position encoder, and an alarm is raised if the expected position is inconsistent with the actual position.

15. A robot head as claimed in any one of claims 8 to 14 in which the first axis is perpendicular to the second.

16. A robot head as claimed in any one of the preceding claims in which the arm is extendible along a third axis.

17. A robot head as claimed in claim 15 and claim 16 in which the first, second and third axes intersect at a point.

18. A robot head as claimed in claim 16 in which the arm is extendible on a third lead screw which is rotated by a third rotational motor.

19. A robot head as claimed in any one of claims 16 to 18 including a third output position encoder for measuring the extension position of the arm.

20. A robot head as claimed in claim 18 including a third input position encoder for measuring rotation of the third motor.

21. A robot head as claimed in claim 19 and claim 20 in which the measurement from the third output position encoder is compared with an expected arm extension position based on the measurement from the third input encoder, and an alarm is raised if the expected position is inconsistent with the actual position.

22. A back-drivable robot head including:

(a) a manually-graspable driving member;

(b) a force sensor for sensing forces applied to the driving member by a user;

(c) an arm for carrying a tool the position of which is to be controlled; and

(d) a first rotation control mechanism for rotating the arm about a first axis in response to the sensed forces;

characterised in that the first rotation control mechanism comprises a first rotational motor (30'), an output of which is converted first to longitudinal motion and then back to rotational motion of the arm.

23. A back-drivable robot head including:

(a) a manually-graspable driving member;

(b) a force sensor for sensing forces applied to the driving member by a user;

(c) an arm for carrying a tool the position of which is to be controlled; and

(d) a first rotation control mechanism for rotating the arm about a first axis in response to the sensed forces;

characterised in that the first rotation control mechanism comprises a first rotational motor (30'), an output of which is converted first to longitudinal motion and then back to rotational motion of the arm; the head further

including a first input encoder for measuring rotation of the first motor (30'), a first output encoder for measuring the angular position of the arm about the first axis, and in which the measurement from the first output position encoder is compared with an expected arm position based on the measurement from the first input position encoder, an alarm being raised if the expected position is inconsistent with the actual position.